Chapter-I

INTRODUCTION

Forest fires are very common problems that have significant impacts on terrestrial, aquatic and the atmospheric systems throughout the globe. Every year, the world faces extreme wild fires, which affect millions of hectares of forests leading to adverse effects on biodiversity, ecosystem functioning and landscape stability. Hence, we need to study the theoretical relations surrounding fires with scientific methodology to discover ways of directing application and the supply of ecosystem services. This includes understanding forest vegetation dynamics in relation to the fire regimes, the role fire plays in the provision of ecosystem services and the social background behind fire applications. This will help us to understand the behaviour of local forest dwellers and to plan landscape-level management, accordingly. However, the climatic patterns can complicate the fire events by further altering the conditions within which ecosystem develop.

1.1 General

A forest fire can be described as an unclosed freely spreading combustion, which consumes the natural fuels of a forest that consist of duff, grass, weeds, brush and trees (Brown and Davis, 1973). Fire behaviour is generally defined as the manner in which the fuel ignites, flames develop and the fire spreads and exhibits other related phenomena, such as fire whirls (Countryman, 1964), as determined by the interaction of fuels, weather and topography (Brown and Davis, 1973). This definition is consistent with that of the National Wildfire Coordinating Group, which considered fire behavior as “the manner in which a fire reacts to the influences of fuel, weather and topography”. The popular fire behavior descriptors are rate of fire spread, fire intensity and flame length (Kaitpraneet, 1983). Rate of fire spread is the speed at which the fire moves across the landscape. It is the primary descriptor of fire behavior and its prediction is crucial to achieve effectiveness in both wildfire control and the successful application of prescribed burning (Mendes-Lopes et al., 1998). Fire intensity is the rate of heat energy released during combustion and flame length is the distance from the average flame tip to the base of the flame in the middle of the flame zone (Teie, 1997).
Due to increasing anthropogenic fire activity, understanding of role of land cover in shaping coarse-scale forest fire regimes has become a major concern. This is because human presence and impact i.e., population density, agricultural practices and grazing pressure together with the amount of fuel and its spatial distribution are basic factors in explaining fire ignition and its propagation (Lloret et al., 2002). The due importance is to be given to the special characteristic of land cover and fuel because they are closely related and accordingly the probability of fire ignition will be affected to a large extent by the peculiar nature of different land cover types and fuel characteristics (Turner and Romme, 1994).

The ignition risk (i.e. the chance of a fire starting as determined by the presence and activity of any causative agent as defined by FAO (1986) and NWCG (2006) is an essential element in assessing the fire danger (Finney, 2005 and Vasilakos et al., 2007). Nowadays, many fire management decisions are still exclusively based on the factors influencing the fire spread and suppression difficulty. However, as resources are limited, it is important to define priorities among areas. Under similar fuel, topographic or weather conditions, the areas with higher ignition risk should be given top priority for surveillance (Vasconcelos et al., 2001; Chuvieco et al., 2003). The ability to understand and predict the patterns of fire ignitions is an essential task for managers because it will help to improve the effectiveness of fire prevention, detection and allocation of fire fighting resources. The basic knowledge about where, when and why do fires start will improve the ability.

The Indian forests are also vulnerable to forest fires, like other countries, the type and intensity of these forest fires varies from place to place depending upon the type of vegetation and the climate. The coniferous forest in the Himalayan region which mainly consist of coniferous species like fir (Abies species), spruce (Picea smithiana), Cedrus deodara, Pinus roxburghii and Pinus wallichiana are more prone to forest fires every year. One or two major incidences of forest fires in this region are common features. The other parts of the country are dominated by deciduous forests and hence not prone to extensive fires, as coniferous forests are (Bahuguna, 1999). The total geographical area of Himachal Pradesh is 55,673 sq. km out of which 37, 033 sq. km is forest area and about 14,360 sq. km is forest cover of which 1,46,000 ha forest area is sensitive to fire (Bahuguna and Singh, 2002).

Various regions of the country have different normal and peak fire seasons, which vary from January to June (Narendran, 2001) depending on the dry weather conditions. In the plains of northern and central India, most of the forest fires occur between February and June.
In the hills of northern India fire season starts in the later months i.e. April- June when most of the fires are reported. In the southern part of the country, fire season extends from January to May. In the Himalayan region, fires are common in May and June.

In the past twenty years, the fire events in India have strongly been linked with the presence of *El Nino* conditions affecting the monsoon movements (Wang et al., 2004). It is a well known fact to the meteorologists that under *El Nino* conditions, the reduced convective activity leads to the pronounced rainfall deficit throughout the country, and thus a causal factor for regional drought conditions, mainly during the dry season of April – June. *El Nino* events occur in every 2–7 years and not on a regular inter-annual cycle. An implication of *El Nino's* irregularity for fire management in India is that large-scale fire events occur episodically and hence in some years they are not of major concern, making resource preparedness more difficult to plan and maintain on a routine basis. As a result, real-time monitoring and forecasting of weather and fuel conditions are required to be prepared better for such fire events. These activities must be formulated to understand the local fire behavior.

At the same time, the past history of fire depicts that there are very few cases of fire due to natural causes in our country. The majority of the forest fires (99 per cent) in the country are incited due to human interference. It is widely acknowledged that most of these fires are caused by the people deliberately which have a close relationship to their socio-economic conditions. According to Bahuguna and Singh (2002) grazing and collection of minor forest products by villagers like fire wood, biroza, herbs, medicinal plants, honey etc. are the major causes of forest fires in India. Carelessness of the picnickers, travellers and campers are also the other causes for forest fires. It is well documented that the forest fires are calamities leading to severe damage to the forest economy and are considerably greater than all damages caused by the harmful insects and diseases. The fire causes substantial damage to the forest wealth whether caused by natural or anthropogenic factors. Therefore, the problem of controlling forest fire is an important management activity and issue for economic development, besides having a great concern for global warming.

Therefore, vegetation fire is an increasingly important issue in Southeast Asia, including India, owing to the reasons that it has many social, economic and environmental impacts. Since the last haze disaster in 1997–1998 several workshops have been initiated to mitigate these fire-related problems and address the need to strengthen institutional and fire management systems. Consequently, the Association of Southeast Asian Nations (ASEAN)
has identified the need for an early warning system in the Regional Haze Action Plan to provide advanced notice of severe fires and trans-boundary haze episodes (Qadri, 2001). As a result, real-time monitoring and forecasting of weather and fuel conditions are required to better prepare for such fire and haze events. These activities must be based on an understanding of local fire behaviour, which to date has been little studied in the tropics. While fire knowledge is extensive in temperate and northern latitudes, blanket application in the tropics will not be successful without consideration of local fuels, weather and topography (Cochrane, 2003).

The Fire Weather Index (FWI) System has been used in various applications in numerous other countries including the United States (Brenner et al., 1997), New Zealand (National Rural Fire Authority, 1993), Russia (Stocks et al., 1998), Fiji (Alexander, 1989), Mexico (Lee et al., 2002), European countries (San-Miguel-Ayanz et al., 2003) and in Southeast Asian countries i.e., Malaysia and Indonesia (de Groot et al., 2007) for developing Fire Danger Rating System (FDRS). The FWI System was used as the foundation to develop the FDRS that would serve as an early warning system for serious haze and fire problems. FDRS decision aids which detail fire management actions (such as fire prevention, detection, or suppression mobilization activities) may occur at different fire danger levels because of local fire issues and fire management guidelines. The main tasks of the Southeast Asia Fire Danger Rating System Project were to conduct the initial calibration of the FWI System to regional conditions to facilitate development of FDRS based fire management decision aids to address local fire problems and to strengthen technical development, coordination, management and integration of fire systems in the region. To mitigate these fire-related problems, forest and land management agencies require an early warning system to assist them in implementing prevention and management plans before fire problems begin.

The temporal patterns of fire initiation seem to be mostly related with the meteorological conditions, which affect the fire ignition and initial spread (affecting fuel moisture and flammability). The knowledge of these patterns can also have important consequences for fire management, in terms of vigilance and fire fighting preparedness. Efforts have been initiated on these lines in Southeast Asian countries since 1999. They developed Fire Danger Rating System (FDRS) for Indonesia and Malaysia to provide early warning of the potential for serious fire hazards by adapting Canadian Forest Fire Weather
Index (FWI) and Fire Behaviour Prediction (FBP) Systems by considering local vegetation, climate and fire regime conditions.

In Himachal Pradesh, or rather in India, no prediction models are being used for predicting the forest fires. Therefore, an area which was highly prone to forest fires was selected for the present study in Shivalik Hills of Dharampur Forest Range, Solan Forest Division in Himachal Pradesh, India due to the presence of dominant species of pines. In this study area an effort was made to adapt the Canadian Fire Danger Rating System through Forest Fire Weather Index (FWI) and Fire Behaviour Prediction (FBP) Models for predicting forest fires, well in advance, for fire management procedures.

Therefore, the present study entitled, “Meteorology based Prediction Models for Management of Forest Fires in Shivalik Hills, India” was planned with the following objectives; in the initial part of the study, as under: -

i) To Study the Existing Fire Management Strategies and their Efficacy.
ii) To Analyze the Meteorological Data and their Correlation to Strike Fire.
iii) To Access the Perception of Community Exposed to Forest Fires in the Study Area.
iv) To Suggest Prediction Models for Effective Management to Control the Forest Fires.

However as the study progressed, the changes were made in the concept and implementations of the study, which lead to the reframing of the objectives as under :-

1.2 Objectives of the Research:-

1 Existing Fire Management Strategies and their Efficacy
2 Fire Weather Characteristics and their correlation to Fire Strike Rate
3 Social Management – People’s Perceptions
4 Forest Fire Management through Predictive Models

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